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Students' Physical Growth

DEVELOPMENTAL FRAMEWORK
PHYSICAL DIMENSION

Alberta
EDUCATION

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STUDENTS' PHYSICAL GROWTH:

DEVELOPMENTAL FRAMEWORK, PHYSICAL DIMENSION

Alberta Education
July, 1988

Curriculum Support Branch
5th Floor, Devonian Bldg.
11160 Jasper Avenue
Edmonton, Alberta
T5K 0L2

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Mr. Terry Cooke	Northern Alberta Institute of Technology
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Dr. Glen Giduk	Alberta Teachers' Association
Mrs. Janice Leonard	Conference of Alberta School Superintendents
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FOREWORD

> "The aim of education is to develop the knowledge, the skills and the positive attitudes of individuals so that they will be self-confident, capable and committed to seeking goals, making informed choices and acting in ways that will improve their own lives and the life of their community." (Secondary Education in Alberta, June 1985, p.7).

How children and youths think, feel and grow affect how they learn best. Students' physical growth is the foundation of their cognitive and affective development. Accurate knowledge of students' physical growth can inform curriculum developers and assist teachers in choosing among teaching methods. For parents and others who deal with children as well, knowledge of their physical growth is helpful.

Alberta Education has always sought to incorporate into the curriculum what is known about students' growth in all domains. Many people have contributed their ideas and expertise to this work. It incorporates insight built from both research and practice. This Developmental Framework is a statement describing children's development through the schooling years. In all, there are four documents in this series which comprise the framework:

1. Students' Thinking: Cognitive Domain
2. Students' Interactions: Social Sphere
3. Students' Growth: Physical Dimension
4. The Emerging Student: Interrelationships Among Domains

The following work describes the department's position on the physical growth of students. This represents a significant initiative on the part of Alberta Education: to provide a background statement to enable the development of curricula to meet and support students' physical growth. The department intends to incorporate this work into curricula as they are developed. At the school level, teachers and principals play a significant role in assisting students to recognize the importance of the physical domain in the total school program. Parents can also assist their children in developing healthful habits and in understanding physical change and variation.

INTRODUCTION

Students' physical growth is sometimes taken for granted. All students clearly have a physical presence, however, and students' physical growth forms a base for their cognitive, emotional, social and moral growth.

Alberta Education's commitment to considering the nature and needs of the learner is made explicit in the policy statement, Secondary Education in Alberta, June 1985. Also, the Goals of Schooling state that students will be provided with the opportunity and means to, among other things, "Acquire knowledge and develop skills, attitudes and habits which contribute to physical, mental and social well being."

Physical education has an explicit responsibility for the development of students' physical skills. What is less commonly recognized is that all teachers must deal, to a greater or lesser extent, with the variety in students' physical growth.

In fact, individual variation is what marks physical growth. This variation is also present in cognitive, social, emotional and moral growth, but in the physical dimension individual differences are seen most easily. For example, children vary widely in their size: some are tall and heavy, others short and light. Children also vary in the rate of their growth and the timing of their growth rates. It is important that all school personnel recognize that this broad range of physical diversity is normal.

This paper examines children's normal physical growth in three areas: perceptual, structural and motor development. In none of these areas is the child's growth a single continuous curve throughout the first two decades of life. Physical growth is characterized by periods of rapid growth with periods of slower growth. Consequently, differences and changes in growth patterns may affect the timing of certain learning processes.

In reading this monograph, it is helpful to keep in mind a sense of the growing child. Physically (as well as in other domains) children are constantly changing. Their capabilities change qualitatively as they mature.

PERCEPTION

Our senses interpret information from the environment and from ourselves. The systems that take in information from the environment include smell, taste, touch, hearing and sight. Three systems gather information from our own bodies: kinesthesis (sensing our own movement), proprioception (our sense of static position), and vestibular (our sense of balance). These three sensory systems are often referred to together by the same name as one of them, proprioception. Our senses serve as an interface between ourselves, other people and the world around us.

The sensory systems develop over time. Two of the senses, seeing and hearing, allow us to gather information at a distance. It is easier to know who is in a room by glancing around or overhearing voices, for instance, than it would be to have to touch someone's face to find out who is there. Touching, tasting, smelling and moving are senses employed at closer ranges.

Perception is the **active** interpretation of all sensory information. There is general agreement that perception develops according to three broad principles:

1. shifts in the hierarchy of dominant sensory systems,
   (Which system does the person rely on most?)

2. increasing intrasensory communication,
   (How do the senses integrate their information?)

3. accompanying improvement in intrasensory discrimination.
   (How finely can distinctions be made? Is that note a C sharp or a D?)

Infants use their tactile and proprioceptive systems as their dominant systems. As children grow, the visual system gains greater influence. Through experience, children learn to match information from various senses. Finally, children, **and adults learning in a new area**, first can make only global distinctions, and later come to make very fine discriminations. For example, initially, a person may be able to distinguish only the general flavours in a dish. A connoisseur, however, has learned to distinguish not only general flavours but also the small amounts of herbs and spices that make up the subtle flavours of that dish.

We learn through all of our senses, and the development of all senses has an impact on students' learning. Most parents and educators, however, are familiar with only two of the sensory systems. These are the visual and auditory systems. The following discussion reflects the central position of these two systems.

FROM INFANCY TO PRESCHOOL

Infants can hear even before birth to some degree. Initially they rely on the hearing and proprioceptive systems for information. Their perception improves dramatically in the first year of life. Physically, the brain and eye mature somewhat. Infants also build a base of experience with objects and events in the surrounding world. As a result of this interplay of experience and maturation, the amount of information infants' perceptual systems can absorb increases and the world comes into focus for them.

A significant part of experiential learning is matching information from one sense with that from another sense. When infants investigate toy trains with their eyes, it is

important that they also investigate the toys through touching, moving, chewing, smelling, throwing and listening to them fall. By using their senses in tandem, infants are able to compare information from one sense with that from another sense. This perceptual matching is an important tool. Whenever possible, it should be provided as part of learning opportunities. Mathematics and sciences offer particularly fertile fields to match sensory inputs to develop concepts and skills.

The value of perceptual matching is not restricted to infant learning, but applies at all ages. For example, in learning to use a mouse control on a computer, it is helpful that pressing the button is accompanied by a "click" sound. The "click" sound matches the proprioceptive feedback from the finger depressing the button. Because there are two sources of information to its action, sound and finger pressure (or proprioceptive feedback), control of the mouse is easier to learn.

A basic aspect of interpreting information is recognizing objects, or form discrimination. Two year olds have difficulty with form discrimination: they are as likely to look at a picture upside down as right side up. Visual and motor systems are not yet completely integrated before the age of three. On the other hand, most two year olds are well able to track moving objects. They can differentiate lateral, horizontal and vertical lines. This ability enables children as young as three to carry out simple map reading skills.

Accuracy of vision and hearing in the early years is limited to short range distances. The resulting ineffective ability to scan in the visual system causes young children to make incomplete and inaccurate judgments. A young child lost at the supermarket may look for his parents, for instance, but be unable to scan the crowd to identify them. Instead, he gets stuck on one face at a time or becomes immersed in a sea of faces.

During the preschool years, eyesight improves and children are able to see finer details at a distance. The eyeball is short and shallow until the child turns six, causing far-sightedness. This far-sightedness makes it hard for preschoolers to focus when activities involve close-up materials such as print or cutting out designs. This is why print should be a larger size, and why such activities should be limited in duration.

As adults, we usually focus on one thing to the exclusion of other things. However, younger children still have trouble attending to one particular task and shutting out unwanted irrelevant information. Children's attention undergoes a major shift between three and six years old. The three year old attends to prominent features of an object - exploring it quickly, impulsively and playfully. In contrast, the school age child increasingly focusses on the informativeness of the object's features - not their prominence.

A key aspect of interpreting sensory information is to be able to focus. It is important to be able to select information, to take some things in and leave others out. As adults, we have all had the experience of suddenly hearing our name mentioned against a background of general conversation. Immediately, we "tune in" and are able to selectively filter the conversation to hear what is being said about us. This skill is often referred to as figure/ground or part/whole discrimination. In this case, our name is the figure, the hum of conversation is the (back)ground. Figure/ground discrimination develops first in the proprioceptive system. A very young child, for example, may have trouble distinguishing an upset stomach as nausea. The child will simply say, "I hurt," unable to localize the hurt.

If figure/ground discrimination is lacking in the proprioceptive systems, it may never develop in other systems. Thus, some children may have difficulty in later years discriminating, say, the teacher's voice from other classroom noises. The ability to discriminate the teacher's voice is critical to effective classroom learning. The difficulty of discriminating the teacher's voice is greater for some voice qualities than others.

The ability to discriminate becomes more fully developed around age six or seven. It continues to mature and improve into adulthood. Indeed, in learning to discriminate in any new area, we must transfer this skill and learn again to distinguish the significant and the relevant from the information available. Experience plays a part in this development, as does physical maturation.

A tremendous amount of students' later ability to learn effectively depends upon their perceptual development in the preschool years. Since all the information they have to learn with must come in through their senses, all their learning depends on the quality of that ability to deal with incoming information.

THE ELEMENTARY CHILD

During the elementary years, perception is refined. School aged children become more focussed, task oriented. As a result they consider the object more systematically and carefully. Because of this, it may take them more time to complete a task than a preschooler would take. This tendency to be systematic increases as children grow older.

It is important for students that schools foster being systematic, which is related to the development of a reflective style. A reflective style is related to academic success. Praising students for quick responses or rewarding them when they have completed a worksheet (before it is checked for accuracy) can instead foster impulsiveness. To encourage reflection, use "wait time" after questions. Of course, it is important that students also recognize which tasks are most suited to a careful, reflective manner. Students should be encouraged to develop a repertoire of styles, and the wisdom to use various ones appropriately.

In general, by maintaining and reviewing incoming information, the learner is able to refine his or her perceptions and thereby progress. For example, the beginning soccer player is at first confused by the large number of players on the field and is unable to distinguish relevant from irrelevant information. The result is that the skills practised earlier in simple drills are forgotten when the game begins and are replaced by harassed kicks at the ball, as the student aims at moving the ball towards the opposition's goal. In time, the beginner is able to distinguish teammates from the opposition and tries to pass the ball to a player instead of just kicking it downfield. Eventually, the player is able to determine which player is free and direct the ball to him or her. At the same age, hockey players focus individually and collectively on the puck, without determining where other players are moving.

During the period from ages 6 to 12, the shift from reliance on tactile and proprioceptive cues to reliance on visual ones continues and progresses. This development is most easily seen through an example. A child of four attempts to jump rope while two adults turn it. The child will have great difficulty co-ordinating body movements with the movement of the rope. The child must first establish a rhythm or pattern of jumping. Once this rhythm is established, the turning rope can be added. However, the movement of the rope must be co-ordinated by the adults to coincide with the pattern of movement already established by the child. The child depends here on kinesthetic feedback, or the sense of the body's movement. In contrast to the four year old, a child of seven or eight does not have to be led into the skill of rope jumping by first establishing a pattern of body movement. The older child can jump into a rhythm already established. This is because that child coordinates the visual system with control of the kinesthetic system. The child can see the rope turning, and can make the body (and the kinesthetic system) follow and match the visual feedback.

The structures of the eye continue to develop during the elementary years. Children now notice the orientation of plane figures on a page, such as whether a square sits on a side or a point. By about six, most children have established binocular vision. Binocularity is the ability of the two eyes to work together as a team. Children can fix their eyes on a point and follow the point. Hence, they can track a line of print. It may be helpful for some children to place a clear plastic ruler under the line of print they are reading. This placement will help guide their tracking if their fine motor control is less developed. Once acquired, these visual skills contribute to the development of the child's motor skills. By five or six, children are as skilled as adults at coordinating their senses.

Visual acuity or the sharpness of the vision improves up to the age of eight or nine. Children can track moving objects and make precise judgments about movement patterns. They can discriminate vertical from horizontal lines, and horizontal from oblique lines. Vertical lines are harder to distinguish from oblique lines, differences among oblique lines are still difficult to distinguish for eight or nine year olds. These difficulties have obvious implications for art, of course, but also for reading. Letters, after all, are varying combinations of different types of lines. Indeed, some eight year olds still reverse letters and numbers right to left or up to down. Thus, even at eight, the ability to discern spatial orientation may still be far from complete. Adaptive motor patterns are still in the making. This is part of the wide variation which is characteristic of children; it is normal and acceptable.

Hearing is a sense already well developed at birth. Children who have repeated ear infections during the years when much language is learned (from two to five years of age) can be slowed in their language development. Even when they continue to learn language at normal rates, they can develop an attitude of not expecting to hear clearly or to learn through this sense. Thus they may not listen as consistently as they should in classroom settings. By school age, three to five per cent of students have developed physical hearing deficits that interfere with learning. In some parts of the province, proportions of students with hearing loss are higher.

Any degree of hearing loss can make learning difficult. For example, the phonics method of learning to read depends on a child being able to hear and analyze the sounds in a word. Preschool and primary children will have

trouble if they have a hearing loss and if phonics is the primary method used to teach them to read.

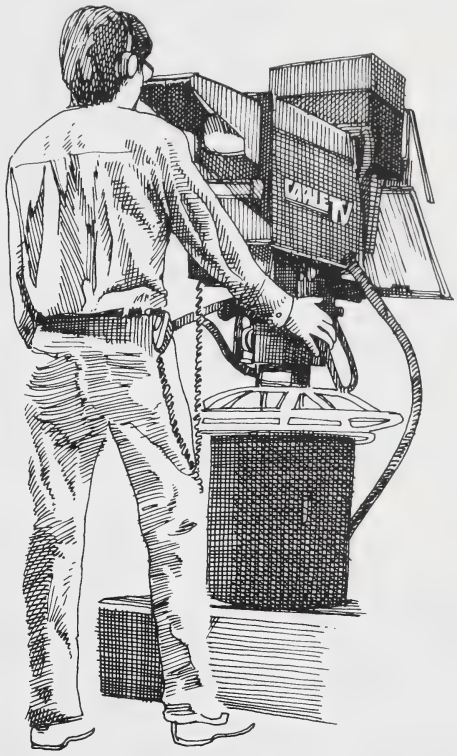
THE ADOLESCENT

Recently, researchers have begun to realize that perception continues to develop and change throughout the life span. For example, the ability to hear high frequency sounds decreases with the onset of puberty. The dearth of research on adolescence reflects an old belief that once a particular perceptual system has matured physiologically, then development ceases.

Of the little research available on development during adolescence, the most useful is that which focusses on visual figure/ground. This research examines the skill which involves perceiving figures as separate from their background. In young children, visual attention is usually directed towards the ground (background) rather than toward the figure. In other words, they may not separate the informative feature from its background. Thus, for younger students, pictures should have simple composition without overmuch visual "clutter."

Skill at distinguishing figure/ground improves from about the age of 10 to 13. Then, adolescents notice the informative figure more than the background. Although there seems to be a marked improvement of this skill between the ages of 8 to 13, this ability seems to continue to improve until 17 or 18 years of age. Over the years, adolescents develop further this capacity for extracting relevant detail out of contexts cluttered with irrelevant information. Perhaps this is why they can study with stereo headphones on! Some students actually find it easier to concentrate on relevant detail when the background is filled with sounds. Other students require the "figure" information to stand out clearly against a background with very little other information. Those students may need silence to study.

This refinement of figure/ground processing involves an increased capacity for handling large quantities of visual or auditory information and for differentiating between important and trivial information. Such development may not be fully complete until late adolescence.



THE SCHOOL AS CONTEXT

Every teacher should be concerned with the perceptual development of his or her students. Since all information comes in through the senses, all teachers deal with students' perceptual development. All teachers can help students learn to discriminate relevant features of tasks by pointing them out and talking to students about them. For example, charts, graphs and diagrams are not automatically easy for students to understand. Skills at recognizing conventions used in these reading aids must be taught, or students will treat them globally and gain little information from them. Social studies teachers explicitly teach these conventions with political cartoons for this reason.

Young students' difficulties with figure/ground discrimination have implications for teaching using audiotapes. The high frequency background noise on audiotapes is inaudible to adults. However students up to the age of puberty can hear it, and also may be less able to distinguish the relevant sounds from the distracting background. This makes the use of audiotapes impractical for many testing situations.

When children enter school, they are still far-sighted. Therefore, their eyes are focussing slightly behind the page they are asked to read. This fact explains why primary print is larger than regular print. It is a little like reading without needed reading glasses: it helps to have bigger print. Since students must have a lot of experience reading connected prose in order to become proficient readers, we must take care with young students to ensure that their books have the larger type which makes this easier.

Now, if we recall that children vary greatly in their rate of development, then it is obvious that they vary in their rate of perceptual development. This has clear implications for children starting school. As children enter school, some will be advanced, while others will take a little longer. If the eyeball matures at around age six for most students, for others it will mature a year or two later. For those students who mature later, reading will be a more laborious task. This does not mean that they will not be successful at it; it means that they must work harder and perhaps through alternate means in order to be successful.

Students' readiness for formal academic learning begins at around age seven or eight, as they enter concrete operational thinking and as their physical structures mature. Some students will make this transition earlier and others later. Alberta Education's Program Continuity Policy is a recognition of the normal range of variation in students' developmental levels.

Young children still need to learn how information from the various senses fits together. Matching information from one sense with that from another confirms the information and reinforces it. Even at later ages, information that comes in through more than one channel is reinforced and so more easily learned and remembered. A real advantage of the learning styles movement in educational circles is that it alerts teachers to the importance of considering **all** the sensory channels in learning. It is important that children have the opportunity to develop many learning styles and not be restricted to either the one the teacher is most comfortable with or the one which they themselves prefer. Many real life problems are more easily solved if structured one way rather than another. Hence, children must have a variety of strategies in their repertoire to solve the variety of problems they will meet in life.

The central role of focussing attention in perception is crucial in students' learning. Selective attention, the ability to attend to the relevant and ignore the irrelevant, is not a singular, simple process. There are many aspects to it (see chart). It is a process that is engaged in continuously, and yet without a conscious awareness of how it is done. For example, just for a moment, think about all the sensory stimuli now impinging on you. You can feel your bottom on the chair, and hear the noise of the fans or machinery around you. Perhaps it is late and you can feel your eyelids getting heavy. You may also be hungry. A car may go by or a child cry out. Yet through all of this you can read and think about what you are reading (at least, until your attention was called to all that input!).

SELECTIVE ATTENTION

1. Alertness - Maintaining arousal or wakefulness

2. Awareness - Recognizing available sets of stimuli and their attributes; identifying available stimuli and recognizing which of them form meaningful sets of information to focus on

3. Focal activation - Selecting which of the available sets of stimuli is most likely to be helpful, informative, and/or satisfying

4. Filtration - Suppressing or relegating to background irrelevant competing sets of stimuli

5. Saliency determination - Appreciating *internal* detail as well as interrelationships between components of the chosen sets of stimuli

6. Feedback - Assessing the quality of the choice made; determining its continuing utility

7. Utilization - Deciding to process, reject, or use a set of stimuli to enhance knowledge or inform an action

8. End point establishment - Determining need to continue or discontinue focus on set of stimuli

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Ensuring that students are "paying attention" in a classroom of 25 or more further complicates the matter. Teachers need to be aware that students may not be "paying attention" for a variety of reasons and that they may not always be able to control their attention consciously. In trying to deal with students' attention spans, it is more useful to think of their "task orientation" time. If students are actively engaged (listening to a fascinating story, building a moving car, manipulating a tetrahedron), they can "pay attention" or concentrate for longer periods of time. On the other hand, if students are passively listening to a teacher's lecture, their task orientation time will be much shorter in duration. Again, it is helpful to recognize that the use of a variety of methods is needed for all children to learn to the best of their abilities.

Finally, it is important to keep in mind that perceptual development is not separate in real children from structural and motor development. Children come as integrated human beings. The child who has difficulty with fine motor development may well have a different rate of perceptual development. Similarly, the child with advanced structural growth may develop sensory structures sooner also. Each of these areas of physical development affects and is affected by each of the other ones, just as it affects and is affected by students' growth in the other domains.

STRUCTURAL GROWTH

Children experience most of their growth during the preschool and school years. Also, they change in body proportions and composition. In these years, children gain in functional complexity and improve in their performance capacities. Finally, they mature sexually. All of these kinds of maturation affect their learning in various ways. Structural growth refers to children's growth in size, including the changes in their bones and muscles. In general, from birth to early adulthood, height and weight follow a four phase growth pattern:

1. rapid gain in infancy through the preschool years,
2. steady gain during the elementary years,
3. rapid gain in adolescence, and
4. slow increase until adult height is reached.

Boys and girls both follow this pattern of growth. As some of us know to our sorrow, body weight, but not height, usually continues to increase into adult life. Overall structural growth follows two principles:

1. Growth begins with the head and proceeds towards the lower parts of the body. Arms grow before legs, for example.

2. Growth begins along the centre of the body and proceeds towards the extremities. The torso, for instance, grows ahead of the hands and feet.

In the following discussion, we will look at students' structural growth in three sections: infancy to preschool, elementary and adolescence.

FROM INFANCY TO PRESCHOOL

Infants and toddlers experience a great deal of physical growth in the first three years of life. Babies increase their length by half in the first year. They double their weight by four to six months, and triple it by one year. After two years of age, children's rates of growth may vary but all slow down. Until adolescence, differences between boys and girls are minor, with boys usually slightly taller and heavier.

The composition of infants' bodies differs from that of adults. Infants' bones are not completely hardened. This is one reason why infants are so flexible. For instance, they have no problem sticking their toes in their mouths. The process of turning cartilage into bones is called ossification. Hand and wrist bones ossify in infancy, but the entire skeleton does not ossify till adolescence. Preschool children still have a larger proportion of cartilage than hard bone. Because cartilage is more easily affected, this leaves them more open to the effects of disease, dietary deficiencies and deformation. Also, if children engage in excessive exercise of one type, they can damage the growth plates on the ends of the long bones in the arms and legs. This, in turn, affects their further growth.

Babies come into the world with most of their muscle fiber already present. However, their muscles are small, watery and underdeveloped. The muscle tissue growth continues through childhood and undergoes a spurt in growth at adolescence.

Babies and small children have different bodily proportions from adults. They have very large heads in relation to the rest of their bodies. Their tummies protrude because the internal organs are housed in a relatively small space. Their chests and abdomens are equivalent in size. Their proportions change in the second year of life. The chest becomes larger than the abdomen. Towards the third birthday, children's leg growth catches up with their arm growth. They become less top heavy as their bodily proportions become more adult like.

Children's brains grow most while they are in the womb and within a few years after birth. As can be seen from the chart, the brain grows very quickly.

Brain Growth by Age

Age	Percent of Adult Weight
6 months	50%
1 year	60%
2 years	80%
5 years	90%

The brain has two basic types of cells: the nerve cells or neurons, and the supporting cells, called the glia. The complement of nerve cells is complete at birth. New glial cells are formed in early life, however. Their growth adds to brain weight.

The brain's growth in the early years occurs through an increase in the number of supporting cells (the glia). The tiny long fibers on the nerve cells also grow by branching at their ends. The brain also matures through adding a covering or sheathing called myelin around the fibers of the nerve cells.

Children's growth is rapid in these early years. In some areas, their growth is more rapid than it will ever be again. The early growth forms the foundation of later growth. Children continue to grow, though at a slower rate, during the elementary years. Adolescence will bring the second spurt of physical growth.

THE ELEMENTARY CHILD

Children's rate of growth levels off by age five or six. Arms and legs grow, and the proportion of body fat decreases. Children begin to leave behind the stockiness of early childhood and look more adult-like.

Although there is substantial variation, an average height for six year olds is about four feet. Girls are slightly shorter and lighter. Two years later, girls equal boys in weight. By nine, girls equal boys in height also. By ten years old, girls are a little taller and heavier than boys until puberty. Children grow about 2 to 2 1/2 inches each year, and by adolescence have reached about five feet.

It is easiest to see children's bone growth in their facial bones and in the long bones of the arms and legs. Their faces become increasingly adult-like and their arms and legs grow longer. Children's bones still have proportionally fewer minerals, more water and more protein-like material than adults' bones have. Children's bones also require a larger blood supply. This makes children less resistant to blood-borne infections than adults. Because the ligaments are less firmly attached and there is more space between bones at the joints, the growing child is more flexible.

AGE CHANGES AND SEX DIFFERENCES IN SIZE AND PROPORTIONS

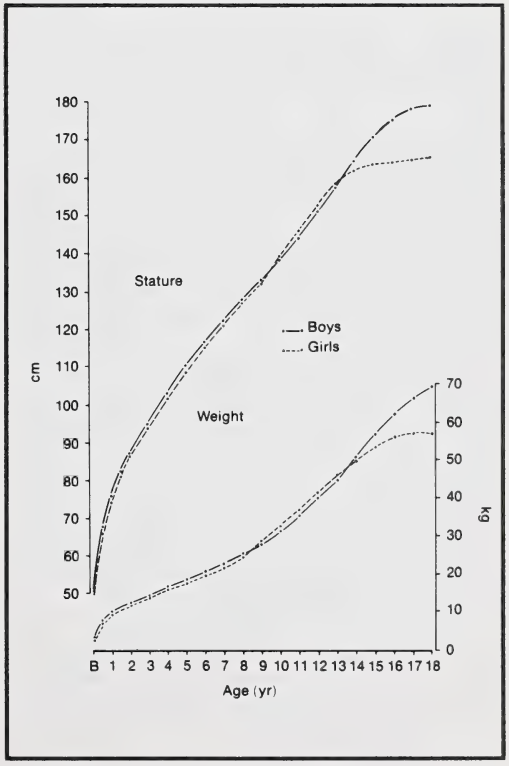
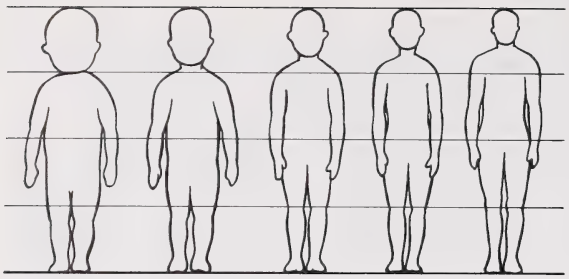


Figure 1.1 Median recumbent length/stature and body weight for American boys and girls from birth to 18 years of age. Recumbent length from birth to two years and then stature. (Based on data from the National Center for Health Statistics 1977. Reprinted with permission of Macmillan Publishing Co. Inc., from R.M. Malina, in Motor Development During Childhood and Adolescence, copyright 1983



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Children gradually increase in muscle mass and strength. Generally boys have more muscle tissue than girls. Though muscle development during the middle childhood years results in greater strength and firmer attachment to the bone, children's muscles still do not function as well as adults' muscles. This can make movement awkward and inefficient. The inability to sit still for long periods of time and the tendency for quick fatigue result from the immaturity of children's muscle tissue. As muscles become stronger, children experience a stronger drive to be active.

Because children's muscles fatigue easily, even (or especially) from sitting still, it is not reasonable to expect primary children to sit quietly in their desks for extended periods of time. They need to get up and move around to release the tension of sitting in one position. Sometimes adults expect children to sit longer than they themselves wish to sit. This is an area where one can note children's variability from one another, too. Some children can barely sit still for ten minutes, but this can be due to muscle fatigue rather than to misbehaviour. It is important to distinguish the reasons why a child may need to move around. It is seldom productive to punish children by having them sit longer when they are in physical pain from sitting as it is.

Development and maintenance of good upright posture requires continuous muscular activity. Poor posture adds an extra burden to bones, ligaments and joints. Habit, poor development of the muscles, or illness can all contribute to poor posture. It can help if children understand that good posture is desirable not just for moral rectitude, but also because it will ultimately result in less fatigue.

Physical activity is necessary to support normal growth in children. It can help to increase one's functional capacity in later life. That is, if you are fit as a child, you will be fitter and healthier as an adult. Of course, as with many things, there is an optimum level of activity for children. Too much exercise can be as harmful as too little. Some activities such as gymnastics, ballet dancing or weight lifting begun too early or carried to extremes can damage students' structural alignment.

The brain's size increases gradually from 90% of adult weight at age five to 95% of adult weight at age ten. It continues to grow mainly through the branching of the ends of the nerve cells. Sometimes the brain "prunes away" or reduces the amount of branching of some of its cells.

To the harrried adult, young children may seem to have boundless energy. However, it is an "internal" pattern: intense activity followed by deep sleep. Children do not have the aerobic capacity or endurance of adults. Their energy is dedicated largely to growth.

Students need lots of high quality foods during the years when they grow rapidly. During the elementary years, when they are growing at a slower pace, the quantity of food they require is not as great, but they still need food with good nutritive value rather than the empty calories provided by "junk" foods.

THE ADOLESCENT

Adolescence is a period of rapid physical growth and change. At this time, growth is more intense than at any stage after infancy. The adolescent is greatly affected by puberty, a process that takes between two and four years. Puberty brings with it an increase in body size, changes in body shape and hormone production, and sexual maturity.

Girls tend to go through puberty about two years earlier than boys. Because of this, girls are temporarily taller and heavier than boys. As the boys go into their growth spurt, they come to exceed the girls in height and weight. Boys usually grow over a longer period than do girls, and this contributes to their greater adult height.

The brain itself shows no signs of a spurt in growth or size at puberty. What changes occur in the brain are probably regulated more at the hormonal level. Of course the branching of the ends of the nerve cells continues. For adolescents, as for younger children and adults, higher order thinking requires the integrated use of both sides of the brain. Indeed, in complex tasks, like writing reports, both sides of the brain are used.

Many of the characteristic changes of puberty are regulated by the pituitary gland. Hormones from this gland stimulate other glands to produce hormones in their turn. Boys and girls begin producing different kinds and amounts of hormones by eight or nine years old. However, outward signs of puberty only become visible at about ten or eleven among girls, and eleven or twelve among boys. The behaviour of both sexes is affected by hormone levels, but may be differentially affected by the different hormones and their levels.

Puberty is characterized by the beginning of reproductive ability for both sexes, at about twelve for girls and fourteen for boys. For girls, reproductive maturity is marked by menarche, the first menstruation. For boys, reproductive maturity is marked by sperm production.

The normal age range for girls to reach menarche varies from 9 1/2 years to about 16. It was once thought that the age of menarche was dropping. However, this has not proven to be true. What is happening is that more girls are achieving menarche earlier than later in the same age range. It is now known that girls younger than nine are not reaching menarche. The trend of more girls maturing slightly earlier is likely due to better nutrition and health care. Even this latter phenomenon appears to have levelled off, however, in populations in developed countries.

It is important for teachers and counsellors to note that menstrual cramping for girls is related to hormonal levels. While some girls' monthly pain and discomfort were once attributed to psychological rather than physical causes, it is now known that high levels of particular hormones are directly related to the pain and discomfort experienced. Girls with such difficulty should seek medical help, as their pain can be alleviated. Menstrual cramping is not related to exercising.

During puberty, males and females develop primary and secondary sex characteristics. Primary sex characteristics include the maturation of the reproductive organs and secondary characteristics include the body shape changes, hair growth, voice change and increased activity of the oil producing glands. There is a typical order to the development of both primary and secondary characteristics. The age at which adolescents begin to develop and the rate of their development vary considerably among individuals.

The early maturing girl may be handicapped by feeling self-conscious. She may try to solve the problems of early maturity by escaping into an older peer group. This resolution can cause social and emotional pressures for which

she is unprepared. A late maturing girl, on the other hand, may have the personal anxiety of wondering when (and sometimes if) she will mature. She does, though, have the advantage of time to adjust more gradually to her changing body.

The early maturing boy has greater physical strength and size, which often makes him superior in athletic ability - an important basis for acceptance and leadership in early adolescent peer groups. A disadvantage for those who mature early is that adults may make greater demands of them because they look older. The late maturing boy is at a disadvantage. While he may be well coordinated, he is too small to compete effectively in competitive team sports. Better choices for sports are those for which classes are formed by weight or by ability. An underdeveloped boy may even be an object of ridicule for other adolescents in a hurry to be done with childhood.

The amount and rapid rate of physical change in adolescence consume a lot of energy. Parents may notice this in their food bill; adolescents need extra calories. It is important, particularly for girls, that these extra calories come from nutritious foods rather than junk foods.

The rapidity of the change during puberty can be threatening and difficult. When adolescents are "out of step" with their peers because of early or late maturation, life may be even more difficult. It is ironic, yet perhaps understandable, that at an age when students show the widest possible variation in physical development, they most want to conform and be alike.

THE SCHOOL AS CONTEXT

Schools affect students' physical growth through the way activities and lessons are structured. The younger the child, the more learning requires manipulation of objects and sensory investigation. This is why it is so important for students to use manipulable materials in learning mathematics and science concepts. The need for this dimension to learning continues throughout the school years. It is critical to preoperational learners (ECS-2), highly significant for concrete operational learners (2-12), and useful even for formal operational learners or adults in learning concepts in an area new to them.

School staffs can also contribute to the attitudes students learn about people. For instance, in our society, great premium is placed on physical attractiveness. Attractive people are often judged to be smarter or nicer than unattractive people, even where there is no basis to make such a conclusion. For example, people will say, in looking at a picture of an attractive person, that the person also appears smart and good. Teachers need to be sure that their interactions with students are fair in the sense that unattractive children also receive the attention and compliments that attractive children receive. It is better to compliment students on their good grooming rather than on their sheer good looks. The former rewards effort, the latter biological accident.

Our attitudes and habits about food and exercise are also learned from the people around us. Like most social learning, these attitudes are mostly learned through modelling and mediation. Hence, students will learn to eat properly and exercise regularly if the people around them do so.

While the school cannot alter students' physical natures, it can assist the home in helping students to develop lifelong habits of

good nutrition. ECS and elementary school snack programs can be one method of teaching students about nutritious foods. Elimination of "junk" foods from the school's vending machines can show a commitment to healthy eating. Further direct teaching suggestions are contained in the elementary and junior high health curricula and the career and life management course.

Similarly, schools can help students to develop lifelong exercise habits. Regular exercise is needed for full development of the bones in both children and adults. Children who are fit will be more fit as adults, even if they do not exercise regularly in adult life. Their cardiovascular system is healthier and their lung capacity is greater. Hence it is crucial that children experience regular physical activity from their childhood years.

One way for students to accomplish the goal of being fit is to engage in daily physical activity. An elementary school called Vanves, in France, experimented with having students engage in physical education on a daily basis. The results were positive not only in terms of students' fitness, but also in terms of their academic work. Perhaps because of the exercise and their greater fitness, they were better able to attend during their academic classes and so learned more.

Exercise is also advocated as the best way to help obese students become slimmer. They don't really need to lose weight: they need to maintain weight while they continue to grow. Counselling obese children and adolescents must include increasing their self-esteem as well as attending to their physical needs.

In all classes, teachers should recognize that students need to move around and stretch periodically. Particularly in situations where there are "double classes," students benefit from an opportunity to change positions.

Finally, teachers' awareness of the nature and intensity of physical changes during puberty should allow them some compassion in dealing with early adolescence. This period of great change consumes a lot of energy, and a part of students' variable behaviour at this stage is due to the demands growth makes on their physical being.

MOTOR DEVELOPMENT

Our bodies were designed for moving, not resting. As children grow, they learn to move in more controlled and efficient ways. Motor development is the increasing ability to control the body's movement through space.

By the age of two, youngsters guide their movements through internal understandings relating to:

- gravity
- static balance (such as standing)
- dynamic balance (such as moving or running)
- motion
- leverage
- force
- space/time
- mass/weight
- inertia

By age two, children have had a lot of physical experience. They have developed a repertoire of movement patterns. A movement pattern is a chain or series of routine actions which a person can do without conscious thought. Riding a bicycle is a movement pattern, and so is signing one's name.

Two things are important about movement patterns: 1) they become automatic, and 2) everyone has a large and varied number of them in his or her repertoire. Since everyone has a limited capacity for attention, the more movement patterns are automatic, the more one's attention is free to do other things, such as think. In learning to write, for example, a young child must use some of his or her attentional capacity in concentrating on how to hold the pencil or crayon. Some attention is used in remembering how the letters are formed.

All this means is that there is less attention left for what the child wants to say. Similarly, at a senior high level, drafting teachers often report that students make "silly" spelling errors when doing lettering or plans. The same phenomenon is at work here: the students are concentrating so hard on forming the letters correctly that they may not have enough attention left to spell carefully. Students **can** spell the word, but overlook the correct spelling because attention is concentrated on letter formation for an instant.

At a later, more skilled stage when the movement pattern is automatic, we can again turn our attention to consciously refining our movement patterns. The more movement patterns we have made automatic, the freer we are to attend to other things. This is as true of walking, running, riding a bicycle or driving a car as it is of writing or keyboarding.

All of these movement patterns need practice to become automatic. The amount of practice required varies with the complexity of the pattern and the skills of the learner.

In this society, the automatic performance of many complex motor tasks is taken for granted. As long as students perform most of the expected developmental tasks at approximately the same age as others, there is little concern. We often do not recognize the complexity of learning new motor tasks, or the effect of smooth motor performance on other endeavours, such as in the cognitive, emotional and interpersonal domains. We seldom reflect upon the need for a variety of motor learning tasks in developing the whole student.

The most appropriate emphasis for the developing child is a broad exposure to many types of motor performance. Different activities require different mixes of skills. A broad range of exposure maximizes all motor learning, and helps students to find some areas of success. Our goal should be to help each child achieve full motor potential as one step in fostering his or her development as a full and total human being.

Overall, motor development reflects the following factors:

1. numerous mechanical principles influence the actual performance of all movement tasks;

2. general physical movements precede specific controlled movements;
3. individuals are often at different stages of development within and between tasks;

4. each individual's developmental schedule is unique;

5. opportunities for practice, encouragement and instruction play a key role;

6. broad exposure and opportunity to learn many different motor skills are vital.

In discussing the development of students' motor abilities, we will first examine their gross motor or locomotor abilities, and then move to small muscle control or the fine motor abilities. It is possible for students to have very good locomotor skills while having relatively weak fine motor development. This would be the young hockey player who skates very well, but stick handles poorly. In schoolwork, this student is likely to be in difficulty over poor handwriting. The reverse pattern, slower gross motor with better fine motor development, is also possible.

FROM INFANCY TO PRESCHOOL

Locomotor Development

The child learns to use the muscles of the body to move his or her body through space. This locomotor development involves a sequence of maturational stages. One or two stages in the developmental sequence are occasionally skipped by a particular child, but most children progress through them all. There is great individual variation, however, in the rates at which children progress through these stages.

Infants achieve a succession of developmental milestones. They:

- lift their heads in the first week of life;
- crawl (tummy on floor) between six and eight months;
- sit by themselves by nine months old;
- creep (on all fours) at about ten months;
- cruise (holding on to furniture) at about one year; and
- walk after one year.

During the second year, children are called toddlers since they "toddle." Because they are top heavy, they must spread their feet wide apart to balance. Their posture for walking includes a forward tilt. Knees and elbows are bent and arms are held forward. Their toes are turned outward. All these characteristics make the one year old's walk into a toddle.

As they practise their toddle, it becomes less pronounced. The spread between their legs gradually narrows. Balance becomes more steady; hands drop to the sides. Additional motor movements are added to the repertoire: stopping, turning and bending over.

Eventually, children lose their forward tilt, become less clumsy, and stop toddling. As walking is refined, they begin to place their feet straight ahead. By two, their steps measure about half the length of adult footsteps. After three, strength, speed and coordination improve a lot. By age four, balance is more developed. Some five year olds even manage two activities at once; for example throwing a ball while running.

Fine Motor Development

Fine motor movement is the use and control of the small muscles of the body, particularly those of the mouth, fingers, toes and eyes. An aspect of fine motor ability is coordinating what is seen with the eyes with the movement of the hands.

At around two months, infants can swat at objects and grasp objects placed into their hands. They can bring objects to their mouths but not accurately or directly. At four months of age, infants can stretch their arms in the general direction of an object. Their eyes may shift from object to hand and back again. At five months, infants can keep their eyes on the object and reach for it directly. The appearance of this ability signals that eyes and arms are coordinated and the infant's visual motor systems are now well integrated. By about nine months of age infants can use their thumbs and forefingers in a "pincer" grip to pick up small objects. By one year old, they have learned to throw objects, such as cereal, often to the dismay of their parents.

During their second year, children become more fully right- or left-handed. In new and unfamiliar activities, they may still use both hands. The preference for one hand over another increases until seven or eight years of age. Thus, in Grades 1 and 2, it is still normal for children to try some activities with either hand. Handedness results from a combination of inherited and environmental influences. Trying to change a child's handedness can be emotionally harmful. Most authorities advise parents and teachers to allow children to use whichever hand is most skilled.

Typical three year olds can draw with a crayon, feed themselves, unbutton most of their clothes and put on their shoes. At four, improved eye-hand coordination will permit fine motor skills such as zipping, turning knobs and cutting with scissors. In the preschool years, fine motor movements develop and are refined into smooth, precise movements.

THE ELEMENTARY CHILD

Locomotor Development

The locomotor abilities of school children do not improve as dramatically from age six to twelve as they do from birth to five. However, there is an overall and gradual increase in their ability to control their bodies and to perform a variety of complex motor skills. During these years most children are learning and refining fundamental motor tasks so that the overall movement approximates that of a skilled adult. While elementary children can sit longer than preschool children, they still benefit from regular activity throughout the day.

When children enter school they can run, climb, gallop and hop with some proficiency. Skipping is well on its way to being mastered, as are throwing, catching and kicking. Balance is reasonably good. Striking or hitting ability is somewhat weak unless children have the opportunity to practise.

During the elementary years, children grow taller and heavier, but not proportionately stronger. These children are very flexible, but may not know how to use this asset to best advantage. As children grow, they become more flexible in some regions and less flexible in others. During the years between six and twelve, boys are stronger than girls in the shoulder and hip regions. As a result, boys have greater grip strength, throwing speed and jumping capabilities. In co-ed situations, this difference should be taken into account. Boys and girls cannot be fairly judged by the same standards for all activities.

For most physical activities during middle childhood (the period between the ages of six and twelve), neither body size nor sex is as important as age and opportunity. Short children can become fast runners, boys can do cartwheels and girls can hit home runs, if they spend enough time practising, and if they are given the aid and encouragement necessary. The neurological prerequisites for the normal child to learn these skills are present. The opportunity to practise and be coached definitely helps children to improve their skills.

In middle childhood, movement patterns and motor skills change subtly, becoming more efficient. The mechanics of movement such as proper timing of the movement of body segments, application of force and absorption of force are being perfected. By age twelve, most children have developed 85 to 90 percent of their potential speed of reaction and mobility. Therefore, it is not surprising that nine to twelve year olds really enjoy races, stunts and self-testing activities.

Development of strength, balance, speed and coordination occur partly as a function of time. A child becomes better in all these requirements of skillful performance as a result of growth and appropriate experience. A part of experience should be a systematic progression from the simple to the more complex. Further improvement and refinement of skill, though, require years of practice and experience.

School children can become amazingly proficient in some sports. However, there is a danger in over-specialization. Children need a variety of opportunities in order to develop a wide range of motor skills. Specialization should come later for most children and should be based on enough experiences so that choice can be made wisely and realistically. Variety is important for total body development. Specialization promotes development only of specific parts of the body.

Emphasis should be put on the child's own progress, not on comparing achievements with those of others. So great are individual differences that even by the fourth grade there may be a gulf between youngsters as wide as a six year span. Approaches to and expectations for motor learning must differ from individual to individual.

Fine Motor Development

During the elementary years, children develop their fine motor control in a variety of ways. Two activities, however, place high demands upon these skills: reading and writing. During reading, children's eyes must focus on and flow smoothly across a line of print. Very few reading difficulties are caused purely by visual problems. However, reading speed may be slower and more laborious for students whose fine motor skills are less well developed. The greater difficulty of performing the task may make it less enjoyable.

In writing, two sources of feedback guide finger movements: 1) the visual feedback and 2) the proprioceptive systems (internal feedback from one's muscles about their placement or movement). Visual feedback is used in tasks such as drawing, sewing or fixing bicycles. Proprioceptive feedback is used in writing. Most people, for example, can sign their names reasonably well with their eyes closed.

In learning to write, children initially use visual feedback, but soon switch to proprioceptive as the process becomes automatic. Proprioceptive feedback is much faster. This automatism of the hand-writing process must be accomplished twice by students in elementary school - once for printing (or manuscript) and once for writing (or cursive script). It is easy to forget that during writing, movements in the fingers, wrists, arms and shoulders plus movements of the eyes and perhaps head for monitoring all have to be coordinated.

In learning to write, there is a natural transition from visual to proprioceptive feedback for most children. In learning keyboarding or typing, however, we attempt to get students to learn through proprioceptive feedback right from the beginning. (This is called "touchtyping.") If one learns to type or keyboard by using visual feedback (such as looking at the keys or the screen), it is very difficult to shift to using only proprioceptive feedback. In any case, keyboarding is also a set of motor patterns which must be learned to automaticity to be truly useful. This takes less work than might be true of some other motor patterns, however. As little as a semester's work 3 to 5 times per week can establish the patterns, though they must be regularly maintained after that period.

In the elementary years, school children rapidly improve in laterality, the ability to distinguish right and left sides of the body, and to prefer one of those sides. Most six year olds can distinguish their right from their left, but they have trouble relating the orientation of their body to others. Persistent difficulty in laterality can result in problems such as letter reversals and the incorrect placement of letters in words or digits in numbers. Laterality continues to develop through the elementary school years. Laterality concepts are related to spatial concepts. Spatial concepts underlie many mathematics concepts such as place value and geometry.

THE ADOLESCENT

Locomotor Development

More than three-quarters of motor skills development and motor skill interests have been traced to an age of twelve or younger. The implication of this is that adolescence is a time for skill refinement, and for the learning of a wider variety of motor skills.

In general, adolescents experience this period as a time of efficient learning in motor skills and performance. During the adolescent's growth spurt, there may be a period of temporary clumsiness. This may be due to differential growth of various body parts, and to a changing sense of balance.

Girls' physical activity often drops off at adolescence; however, there is no physical reason for this. Both sexes are capable of vigorous physical activity. Adolescents often

have the time and interest to practise intensely. It can be a time to specialize in a set of sports or activities.

During puberty, adolescents vary greatly in their motor development. For many, this stage is a time of great motor accomplishment. Those with good fundamental skills and a wide variety of motor experiences can accomplish significant motor performance feats, even if they did not train intensely as children.

Adolescents can be involved in any activity at a recreational or at a skill level. By participating in sports or in exercise programs, one develops general fitness or functional fitness. Functional fitness refers to the health of an individual, which enables them to perform daily tasks. It includes:

- body composition
- cardiovascular fitness
- flexibility
- muscular endurance
- strength

Each activity develops specific areas of motor skills. Some skill related aspects of fitness include:

- agility
- balance
- coordination
- power
- reaction time
- reaction speed

As adolescents learn and compete in different activities, they build a background of experience. Experience and instruction will help the performer to make wise decisions about his or her performance. Thus, a skier will learn what type of exercise is needed through the summer months to remain in condition for winter's activities.

Of course, not all adolescents will strive to excel at all physical activities. Those less interested in superior sports performance may still find adolescence a time for achieving their greatest motor skill accomplishments. In adolescence, many people achieve proficiency in a wide variety of activities and games. Certainly, adolescents with good experiences in childhood will have acquired the basic fundamental motor skills. However, while most fundamental skills can and should be learned in childhood, this is not always the case. There are children who reach adolescence without some basic abilities to perform fundamental skills such as throwing, catching, or striking. Just as the prognosis is not good for a 7th grade non-reader, the prognosis is not good for a 13 year old who has lower ability to perform fundamental motor skills. It is not surprising that these young people, less able to perform fundamental motor skills, have little interest in learning such skills. This situation is unfortunate because the teen years are often the most active years. Young men and young women achieve skills and fitness levels during their teens which will never again be equalled in their lifetime, unless they continue to work at maintaining these skills and fitness levels.

Fine Motor Development

Fine motor skills are often assumed to be fully developed by adolescence. However, the use of these skills can be affected by the changing demands of schooling in the junior and senior high years. In elementary school, students are not expected to write a great deal in one sitting. The emphasis is on getting information from activities. Beginning in the junior high grades, students are required to produce a great deal more writing, and to do a great amount of reading.

This increase in the productivity required of students can create difficulty for students whose fine motor control is not as effortless or automatic as others'. These students may be accused of laziness because, although they can write, their writing is perhaps not very legible nor of sufficient length compared to others' work. In fact, these students are working very hard, though with less visible effect. For some students with fine motor difficulty, a word processing program on a computer can make the writing process more manageable. It is best to tie facility in keyboarding skills to the student's own cursive writing speed. This standard ensures that a student who has difficulty with fine motor skills is not penalized again in learning the bypass strategy of word processing.

Physiologically, fine motor development may not be completed until the twenties. Certainly, in learning musical instruments for example, the fine motor skill required takes many years to perfect. Students must still practise to become proficient at new fine motor tasks. This process of refinement recurs whenever we must learn tasks new to us. For example, we may all need to learn to keyboard as the computer revolution overtakes us. Many people also choose to learn new crafts requiring fine motor skill in their adult years.

THE SCHOOL AS CONTEXT

Motor development in a school context is often dismissed as the domain of the physical education department. Nothing could be further from the truth. Students who are clumsy because their gross motor (locomotor) skills are relatively weak will be affected not only in athletic pursuits, but in walking around the school and in classrooms. In the hallways, they may bump into others (which affects their social relations) or corners of objects. In the classroom, they may drop books, causing the teacher to think them disruptive.

Students with fine motor difficulties may *learn* well, but be less able to demonstrate their learning through writing it all down for the teacher. Often accused of laziness, these students in fact cannot produce the volume of work required, particularly in the secondary grades. Thus they may become identified only in junior or senior high school, as the workload augments.

One of the major factors that affects the acquisition of motor skills is the **need to practise**. This is as true of the teacher setting up a writing practice as it is of the band leader or coach. It should be recognized from the onset that in the learning situation it is the teacher or coach who sets up the environment. The following comments serve only as guidelines for setting up successful practices:

1. Within a practice:

* As the amount of practice increases so does the psychological reluctance to continue and, as a result,

performance deteriorates. One way to overcome this reluctance is demonstrated in the following example: if you wish the players on the basketball team you coach to shoot 50 free throws every practice, it would be better to have them shoot five sets of ten, alternating with a partner, than to shoot 50 without a break. For a hand-writing practice, alternate letters should be practised. The practice of individual letters, if used, should also be alternated with connected writing.

* Mental and physical preparation aids subsequent performance. If a person rests before engaging in physical activity, the warm-up state may be lost. The amount of loss of readiness depends on the length of the rest. Therefore, the first few trials after a rest interval actually serve as the warm-up, and are often interpreted as poorer performance. One suggestion to accommodate this is to use a pre-game or practice warm-up. Practice ten free throws, stop for instruction, take a couple of jump shots or lay-ups then take ten more free throws.

* There is often an apparent improvement in performance over a period of no practice. This may simply represent a recovery from physical fatigue. It may, however, represent unconscious mental practice. Regardless, this apparent improvement is most often experienced when one is beginning to learn a skill or as one is achieving mastery of that skill.

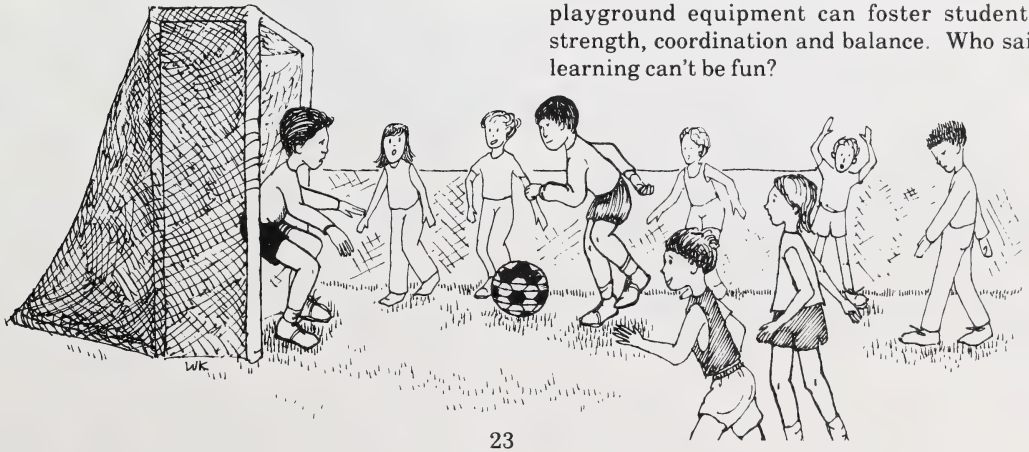
2. Between practices:

* Initially, over the first three weeks, practising every day results in better performance than practising on alternate days. After four to five weeks, there is little difference in performance skill whether one practises daily or on alternate days provided the total amount of practise time is held constant. (This is not to be confused with the benefits of daily physical activity, however.)

One frequently ignored alternative to physical practice is mental practice. Mental practice can serve to review a skill prior to performance, to rehearse various responses, or to consolidate or organize prior learning by focusing on key elements. Although mental practice is never equivalent to physical practice, it is a useful addition. One can try having students visualize themselves performing a particular skill repeatedly as an aid to improving performance.

For younger students, it is best to teach as large a part of an activity as the learner can manage. This holistic learning is preferable because a child's perceptual and integrative capacities are not as great as an adult's capacities. Teaching separate parts of a skill can have a place, but can also leave students unable to integrate the subskills into a smooth performance. Subskills should be taught in the immediate context of the whole.

Finally, it should be recognized that the types of physical setting and equipment provided to students can beneficially affect their development. Specifically, careful choice of playground equipment can foster students' strength, coordination and balance. Who said learning can't be fun?



CONCLUSION

While it is obvious to all of us that students are physical beings, we often overlook the influence of the physical domain on their learning. Our information comes to us through our senses. This information must be made sense of in the brain. This is not a passive process: we interpret information actively. Even after the physical structures mature, we must still learn to use our senses, as well as learning through them.

Children differ physically, one from another. This variation is normal. Just as each person looks different from each other person, so each student's balance of physical skills will be slightly or greatly different from all others. Success or lack of success in physical skills are very public: everyone can observe motor performance and judge. This can be humiliating for a less able or less experienced student. Students very successful at motor performance may be tempted to develop only in that domain, and neglect their development in other domains. In school we must cope with this range of variation and seek to develop students' skills in all domains.

For the curriculum developer, knowledge of the normal variation in students' capabilities can help to suggest appropriate activities, and appropriate amounts of activities to support curricular content, including remedial and enrichment activities for students requiring such modification. The levels approach used in the secondary physical education program is one example which takes account of this variability in student experience and abilities. The materials used to develop students' writing through use of a word processor is another example of the application of this knowledge in curriculum support materials.

Physical development, particularly perceptual development and fine motor development, is the responsibility of all teachers. Some physical skills are used in all classes, and students practise their skills between classes and outside of school. It is helpful for all teachers to understand students' capabilities in setting expectations.

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